these were pronounced, world-shaking earthquakes had been frequent. A comparison of the varying number at different periods of small earthquakes showed that the number recorded increased ; but this was evidence, not of the growth of seismic activity, but of more general observation. Nearly all large earthquakes were followed by a long series of after-shocks. For example, after the disturbance of October 28, 1901, which had its origin in Central Japan and which might be regarded as a typical world-shaking earthquake, during the first twelve months, 2956 shocks were noted. Next year the number fell to 391. The conclusion seemed to be that in any given year there were 27,500 shocks which could be recorded in epifocal districts, and that, on the average, there annually were 30,000 small earthquakes. From seismograms obtained in epifocal areas, measures of earthquake energy had been obtained. The result was that engineers and builders were now able to build to withstand known forces, and in Japan, in particular, effectual methods had been adopted to resist the severe shakings to which that country was subject. The Japanese Government had so far recognised the importance of seismology as to establish professorships to encourage its study.

THE ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW.

NOT many scientific societies of the kingdom can boast of having existed for a hundred years, but the Royal Society of Edinburgh a few years ago celebrated its centenary, and last week what is now known as the Royal Philosophical Society of Glasgow was engaged in celebrating the attainment of its hundredth year, for it came into being on November 9, 1802, with sixty-two of the most prominent men in the city as members, many of whom have since acquired prosperity and reputation. There was Dr. William Meikleham, the professor of astronomy and natural philosophy in the University, and who was Lord Kelvin's predecessor in the natural philosophy chair, so that those two men practically covered the century between them. There was also Dr. George Birkbeck, subsequently a professor in the " Andersonian," and the founder (in London) of mechanics' institutions. Patrick Cumin, another foundation member, was the professor of Oriental languages. A particularly notable man in the membership was David Mushet, the discoverer of the famous blackband ironstone which did so much to make Scotland the leading element in the creation of the iron industry. Among other original members were Charles Macintosh, who originated the " macintosh " as an article of clothing for wet weather ; Mr. John Roberton, a famous iron-founder, who read many papers in subsequent years ; and Mr. William Dunn, of Duntocher, a well-known machine-maker. Mr. James Boaz was an accountant ; he took a warm interest in the Society, and became secretary in the year 1804, remaining in that office to the great credit of the Society for twenty-six years. Sundry other original members might be named and descanted upon, men from the very highest ranks, and who collectively made Glasgow or contributed very materially towards it, but we must refrain from doing so. Worthy John Geddes, of Verreville, glass manufacturer and potter, was an early member, and he was the second president. The Society did not publish any *Proceedings* or *Transactions* until the year 1844, after Dr. Thomas Thomson, F.R.S., had become president. That gentleman was the famous professor of chemistry in the University, and his knowledge was frequently called forth during the eighteen years that he held the office of president. Mr. Walter Crum, F.R.S., famous as a scientific calico printer, succeeded Dr. Thomson in the chair, and then there was a somewhat continuous run of University presidents, such as Dr. Allen Thomson, F.R.S., Prof. Wm. Thomson, F.R.S. (now Lord Kelvin), Prof. Thomas Anderson(distinguished as a chemist), Prof. W. J. Macquorn Rankine, C.E., F.R.S., and Prof. Henry D. Rogers (American geologist). After he had been knighted, the professor of natural philosophy was again made president for the years 1874-75-76-77. The Society was always in a position to command the services of able and learned men to take the presidential chair, and business men have always been in abundance to fill the executive offices and to discharge the duties pertaining to them for periods extending from six years (in the case of Prof. McKendrick as secretary) to upwards of thirty years, as in the case of Mr. John Mann, the present treasurer.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An Isaac Newton studentship in physical astronomy and optics, of the value of 200*l.* a year for three years, will be awarded in the Lent term, 1903. Candidates must be Bachelors of Arts who are under twenty-five years of age on January 1, 1903.

IT is announced that a chair of tropical medicine has been founded in University College, Liverpool, with an endowment of 10,000*l.* Major Ronald Ross, C.B., F.R.S., has been elected to the chair.

SIR OLIVER LODGE, F.R.S., was on November 14 entertained at the annual dinner of the Liverpool Philomathic Society, when he delivered an address. He said his removal to Birmingham was solely because of the greater opportunity for his own work which his position in that city afforded him. Speaking of universities, he remarked that the competition among cities to make themselves worthy to become the seat of a university was healthy and holy, and he trusted the movement for establishing a university for Liverpool was gaining ground.

THE second subsection of Clause 18 of the Education Bill, as amended in Committee of the House of Commons on Friday last, lays it down that " the power to provide instruction under the Elementary Education Acts, 1870 to 1900, shall, except where those Acts expressly provide to the contrary, be limited to the provision of instruction given under the regulations of the Board of Education to scholars of not more than fifteen years of age in a public elementary school, but any scholar may remain in such a school to the close of the school year in which he or she reaches the age of fifteen." The difficulty which has existed for some time of defining what constitutes elementary education is thus in a large measure disposed of. An attempt was made to remove the age limit and so allow it to be possible for a child to stay at an elementary school so long as the parents wished. But the intention of the Government appears to be to encourage the drafting of children of capacity into secondary schools, and in this way to reduce expense and also prevent overlapping.

AT the invitation of the University of Cambridge, representatives of all the universities of England and Wales, of the numerous educational associations concerned with secondary education, as well as of the Board of Education, assembled in the Senate House at Cambridge on November 14 and 15 to confer as to the training of teachers in secondary schools for boys. Among men of science who took part in the interesting debates, following the papers on different subjects requiring consideration, were Prof. H. E. Armstrong, F.R.S., Sir Oliver Lodge, F.R.S., Prof. John Perry, F.R.S., and Sir Arthur Rücker, F.R.S. The Vice-Chancellor of the University presided at both meetings, and among the papers, those of Sir Richard Jebb, Mr. Sidgwick and the Master of Marlborough were of particular importance. As Sir John Gorst, whose speech concluded the proceedings, pointed out, if the universities intend to remain at the head of this movement for obtaining suitable training for the masters in secondary schools, they must be progressive and make use of the best of the methods which experience has shown to be suitable to the new demands. One such method, he pointed out, is that by which science is studied by research carried on by the pupils.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, November 13.—Dr. E. W. Hobson, president, in the chair.—The De Morgan medal for 1902 was presented to Prof. A. G. Greenhill.—Mr. Tucker having retired from the office of secretary, the following resolution was proposed by Dr. Hobson, seconded by Dr. Glaisher, and carried unanimously :—" That the thanks of the London Mathematical Society be offered to Mr. Robert Tucker for the eminent services which he has rendered to the Society during the thirty-five years in which he has held the office of honorary secretary." —The council and officers for the ensuing session were elected. They are as follows :—President, Prof. Lamb ; vice-presidents, Mr. Tucker, Dr. Hobson, Dr. Baker ; treasurer, Dr. Larmor ; secretaries, Prof. Love and Prof. Burnside ; other members of

the council, Mr. Campbell, Lieut. Colonel Cunningham, Dr. Glaisher, Prof. Greenhill, Mr. Macdonald, Major MacMahon, Mr. Western, Mr. Whittaker, Mr. A. Young.—Prof. Lamb having taken the chair, Dr. Hobson delivered an Address on the infinite and the infinitesimal in mathematical analysis. He sketched briefly the history of the attempts that had been made at various times to deal with questions of the infinite, and dwelt especially upon the critical work of the latter half of the nineteenth century, pointing out that pertinent criticism of fundamentals almost invariably gives rise to new construction. He explained how the system of analysis, connected with the title "arithmetisation," had turned a difficulty, to which all previous systems were liable, in that they were unable to give a proof of the existence of the limit. He described the character of the numerical continuum, and contrasted its properties with those of other aggregates, which possess unlimited divisibility. He proceeded to recount the objections that had been raised to the introduction of infinite numbers, as opposed to variables which become indefinitely great ; and he concluded with an outline of the theory of transfinite numbers.—The following papers were communicated :—Prof. D. Hilbert, Ueber den Satz von der Gleichheit der Basiswinkel im gleichschenkligen Dreieck. The paper forms part of a critical discussion of geometrical axioms. The possibility of setting up various systems of axioms, so that the axioms of a system shall be mutually consistent and mutually independent, has been proved ; and it becomes important to ascertain the relations of the more fundamental geometrical propositions to the possible systems of axioms.— Prof. Burnside, On linear homogeneous groups. The characteristic determinants of any simply transitive, and of any transitive, linear homogeneous group are discussed, and general forms of the determinants are given ; the results are applied to simplify the proofs of known propositions concerning the continuous group that is defined by any given group of finite order.—Prof. Lamb, On wave-propagation in two dimensions. The divergence, in two dimensions, of waves from a source, of a more or less transient character, is worked out in detail and illustrated graphically. The disturbance begins suddenly at a place when the wave reaches it ; but it does not cease suddenly after a time equal to that during which the source is in action. The existence in two-dimensional wave motion of a sort of "tail" to a wave, which does not occur in the case of waves in one dimension or in three dimensions, is further elucidated by various comparisons between the characters of the three cases.— Prof. A. C. Dixon, (1) Summation of a certain series ; (2) Expansions by means of Lamé's functions. The first of these papers is a development of previous work by Morley on the hypergeometric functions that arise from the consideration of the sum of the cubes of binomial coefficients. The second paper contains a discussion of the use of Lamé's functions to determine a potential from its singularities and boundary values for the following regions :—(a) the interior of an ellipsoid, (b) the exterior of an ellipsoid, (c) the space between two confocal ellipsoids, (d) two distinct regions, bounded by confocal ellipsoids, wholly or partly coextensive and connected together through the area of the focal ellipse.—Mr. W. H. Young, (1) On sets of intervals, (2) Note on unclosed sets of points defined as the limit of a sequence of closed sets of points. The first of these papers aims at developing the theory of sets of intervals on the straight line in a systematic manner ; it is pointed out that, although the discussion of such sets forms a natural introduction to some parts of the theory of aggregates, only a few isolated theorems about such sets have been formulated hitherto. The object of the second paper is to obtain the necessary and sufficient condition that the content of the set obtained by closing an unclosed set, which is the limit of a sequence of closed sets, may be the limit of the contents of the closed sets of the sequence.—Prof. Hill, The continuation of certain fundamental power series. The object of the paper is to illustrate the theory of continuation in simple cases in which the work need not be artificial. The continuations, along arbitrary circuits, of the binomial series, the logarithmic series, the series for arc tan x, are developed in detail. The methods of the paper depend upon theorems proved by Abel in his classical memoir on the binomial series.—Prof. L. Crawford, A geodesic on a spheroid and an associated ellipse. The length of the arc of a geodesic drawn from a given point on a spheroid in a given direction is found as the length of an arc of an ellipse, and the difference of longitude of any point on the geodesic and the given point is expressed as an elliptic function of an angle connected with the corresponding points on the same

ellipse ; an expression is found for the change in longitude on return along the geodesic to the same latitude.—Prof. A. W. Conway, The propagation of light in a uniaxal crystal. New forms of integrals of the equations of propagation are obtained. The results are applied to the discussion of the direction of vibration and the flow of energy ; it appears that the ray direction is not the direction of the energy flux in waves diverging from a source within the crystal. Applications of the integrals are also made to discuss the passage of parallel and of divergent beams of light through a thin crystalline plate.— Mr. E. T. Whittaker, On a new connection of Bessel functions with Legendre functions. A symbolic relation, which connects the functions in the case where the order of the Bessel functions is half an uneven integer, is transformed into an expression for the Bessel functions of unrestricted order as definite integrals involving Legendre functions of unrestricted order.

Chemical Society, November 6.—Prof. McLeod, F.R.S., in the chair.—The following papers were read :—The specific heats of gases, by Mr. H. Crompton. An extension of the application of Le Chatelier's formula for the specific heats of elementary gases to the vapours of complex substances.—The action of nitric acid on bromophenolic compounds, by Mr. W. Robertson. An investigation of the effect produced by displacement of the hydroxyl group by methoxy- or acetoxy-groups in inhibiting the replacement of bromine by nitroxyl.—3:5-dichloro-*o*-xylene and 3:5-dichloro-*o*-phthalic acid, by Drs. Crossley and Le Sueur.—The combination of carbon monoxide with chlorine under the influence of light, by Drs. Dyson and Harden. These gases when dried, mixed in equal quantities and exposed to light, undergo first a period of photochemical induction and finally reach a stage of equilibrium with the carbonyl chloride formed.—The constituents of commercial chrysarobin, by Dr. Jowett and Mr. Potter.—The constituents of oil of rue, by Dr. Power and Mr. Lees. The following new constituents have been obtained :—methyl *n*-heptylcarbinol, methyl *n*-nonylcarbinol, methyl salicylate, cineol, limonene and pinene.—Methyl *β*-methylhexyl ketone, by Mr. H. Lees.—Di-indigotin, by Dr. Moir. This substance was obtained by the application of Baeyer's process for the synthesis of indigotin from *o*-amidocinnamic acid to the diphenyl analogue, benzidine dicarboxylic acid.—The localisation of phosphates in the sugarcane, by Mr. Sprankling.—On the non-existence of the gaseous sulphide of carbon described by Deninger, by Messrs. Russell and Smith.—Isometric anhydrous sulphates of the form $M''SO_4, R'SO_4$, by Mr. F. R. Mallet.—The catalytic racemisation of amygdalin, by Dr. J. W. Walker. The optically active glucoside is converted by the hydroxyl ions of aqueous alkaline solvents into racemic amygdalinic acid.—On asymmetric optically active selenium compounds, and on the hexavalency of selenium and sulphur, by Prof. Pope and Mr. Neville. Methylphenylselenetine has been obtained in dextro- and lævo-modifications by fractional crystallisation of the *d*-bromcamphorsulphonate.—The transformation of acetylchloroaminobenzenes into the isomeric chloroacetanilides, by Drs. Chattaway and Orton.

PARIS.

Academy of Sciences, November 10.—M. Albert Gaudry in the chair.—On uniform transcendentals defined by the equation $y'' = 6y^2 + x$, by M. Paul Painlevé.—On quasi-waves, by M. P. Duhem. From the theoretical examination of the velocity of propagation of sound waves in air, it is shown that if the coefficient of conductivity has a finite value, however small, the waves will be propagated in accordance with the formula of Newton, and it is only in the case where the conductivity coefficient is rigorously zero that the waves will travel in accordance with the formula of Laplace. But although the conductivity of air is small, it is not zero, and this leads to a serious discrepancy between theory and experiment. The author shows that the existence of viscosity in air, although small, renders impossible the propagation of waves properly so called, and examines the conditions of transmission of the quasi-waves which are possible, and succeeds in showing that an explanation of the discrepancy becomes possible.—Further observations and experiments relating to the determination of the velocity of the X-rays, by M. R. Blondlot. According to the theory put forward by Wiechert and Sir G. G. Stokes, the X-rays consist, not of continuous ether vibrations, but of extremely short, isolated pulsations, and this hypothesis has been shown to give a complete explanation of the absence of refraction and reflection and of the diffraction phenomena shown by the rays. All the experimental results obtained by the author are also in accord

with this hypothesis, which appears to render a complete account of all the facts at present known.—Study of the climate of Toulouse from 1863 to 1900, by M. B. Baillaud.—Remarks by M. Haton de la Goupillière on a recent paper by M. Gréhant on the analysis of air from mines.—On the present condition of the volcano at Mont Pelée, by M. A. Lacroix.—Gravity along the mean parallel, by M. J. Collet.—On Cremonian substitutions in space, by M. Léon Autonne.—On the breaking and displacement of equilibrium, by M. Jouguet.—On the equivalence of differential systems, by M. E. Cartan.—On certain remarkable equalities, by M. W. Stekloff.—On Hall's phenomenon and thermo-electric power, by M. Edmond van Aubel. According to the views of Nernst and von Ettingshausen, there should be a relation between the thermoelectric power and Hall's phenomenon in metals. It was found by Becquerel that certain alloys of bismuth and antimony and a mixture of bismuth with bismuth sulphide possess very high thermoelectric power, and these have now been examined by the author with respect to the magnitude of the Hall effect. The results confirmed the theory of Nernst and von Ettingshausen.—On the conductivity of solutions at low temperatures, by M. J. Kunz. The electric conductivities of solutions of sulphuric acid have been determined at temperatures between $0°$ C. and $-70°$ C. The conductivity does not vanish at $-39°$C., as had been suggested by Kohlrausch, but diminishes continuously with the temperature.—Some new experiments on the electrical resistance of selenium and its application to the transmission of luminous images and impressions, by M. Dussaud.—The artificial production of rubies by fusion, by M. A. Verneuil. The exact conditions necessary for the production of artificial rubies have now been worked out, and specimens have been obtained possessing a fine red fluorescence, and which have been found by the lapidaries employed to cut them to possess the same hardness as natural rubies, and to take the same fine polish. Occasionally, rubies have been made which it is impossible to distinguish from natural ones, but as a rule there are slight faults which can be made out on careful examination.—On the alloys of copper and magnesium, by M. O. Boudouard. The fusing points of a series of alloys of copper and magnesium, when arranged on a curve, give three maxima and four minima. The former correspond to the existence of three definite alloys, $CuMg_2$, $CuMg$ and Cu_2Mg. The mechanical properties show a general parallelism with those of the aluminium-copper alloys, studied by Debray.—On the presence of volemite in some Primulaceæ, by MM. J. Bougault and G. Allard. The polyatomic alcohol, extracted from the roots and rhizomes of *Primula grandiflora*, and previously described as primulite, has now been recognised as identical with the volemite of Bourquelot and E. Fischer.—Study of the chemical composition of copal, by M. Marcel Guédras.—On the grouping of crystals of different species, by M. F. Wallerant.—On the development of the ovule in the Asclepiadeæ, by M. Paul Dop. —On the Nubian Sandstone, by M. R. Fourtau.—On the nature of the electric currents of the nerve, by M. B. E. Wedensky.—The *rôle* of the adipogenic function of the liver in the invertebrates, by Mlle. C. Deflandre.—On the existence of arsenic in the animal kingdom, by M. Gabriel Bertrand. The animals examined ranged from the higher vertebrates to the sponges, and in all cases small amounts of arsenic were found. The author concludes that this element forms a fundamental constituent of protoplasm, and points out the bearing of this fact in medico-legal cases.—Remarks on the preceding paper, by M. Armand Gautier. Arsenic is found to be specially localised in the ectodermic organs. It is not peculiar to the animal kingdom, as it has been found in certain Algæ and is probably present in sea water.—On the preparation of a pulverulent sulphur directly miscible with copper solutions, and on the simultaneous treatment of vineyards against oidium and mildew, by MM. A. and M. Campagne.—On the working and feeding of the fountain of Vaucluse, by M. E. A. Martel.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 20.
ROYAL SOCIETY, at 4.30.—Report on the Recent Eruption of the Soufrière in St. Vincent and of a Visit to Mont Pelée. Part I.: Dr. Tempest Anderson and Dr. J. S. Flett.—On the Correlation of the Mental and Physical Characters in Man. Part II.: Miss A. Lee, Miss M. A. Lewenz and Prof. K. Pearson, F.R.S.—Contributions to a Theory of the Capillary Electrometer. II. On an Improved Form of Instrument: G. J. Burch, F.R.S.—An Experimental Determination of the Variation of the Critical Velocity of Water with Temperature: Dr. E. G. Coker and S. B. Clement.

LINNEAN SOCIETY, at 8.—Digestion in Plants: Prof. Sydney H. Vines, F.R.S.—Relation of Histogenesis to Tissue-Morphology: A. G. Tansley. —Stelar Structure of Schizæa and other Ferns: L. A. Boodle.
FRIDAY, NOVEMBER 21.
INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Adjourned Discussion upon Captain C. C. Longridge's Paper on Oil Motor Cars of 1902.—And, *time permitting,* Recent Practice in the Design, Construction and Operation of Raw Cane Sugar Factories in the Hawaiian Islands: J. N. S. Williams.
EPIDEMIOLOGICAL SOCIETY, at 8.30.—What is Climatic Disease: Lieut.-Col. A. M. Davies.
MONDAY, NOVEMBER 24.
INSTITUTE OF ACTUARIES, at 5.—Inaugural Address by the President, Mr. W. Hughes.
SOCIETY OF ARTS, at 8.—The Future of Coal Gas and Allied Illuminants: Prof. Vivian B. Lewes.
ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Western China: Capt. C. H. D. Ryder, R.E.
TUESDAY, NOVEMBER 25.
INSTITUTION OF CIVIL ENGINEERS, at 8.—*Paper to be further discussed*: Electric Tramways: C. Hopkinson, B. Hopkinson and E. Talbot.
ANTHROPOLOGICAL INSTITUTE, at 8.15.—Anthropometric Investigations among the Native Troops of the Egyptian Army: Dr. C. S. Myers.— The Oldest Bronze Age Ceramic Type in Britain: Hon. J. Abercromby
WEDNESDAY, NOVEMBER 26.
SOCIETY OF ARTS, at 8.—Le Tunnel du Simplon, et la nouvelle Ligne de Chemin de Fer Directe Anglo-Italienne pour l'Orient: Prof. Gustave Goegg.
THURSDAY, NOVEMBER 27.
ROYAL SOCIETY, at 4.30.—*Probable papers*:—Experiments on the Effect of Mineral Starvation on the Parasitism of the Uredine Fungus *Puccinia dispersa* on Species of Bromus: Prof. H. M. Ward, F.R.S.—Note upon Descending Intrinsic Spinal Tracts in the Mammalian Cord: Prof. C. S. Sherrington, F.R.S., and Dr. E. E. Laslett.—The Inter-relationship of Variola and Vaccinia; with Special Reference to the Possible Derivation of Cow-pox from the Inoculated Form of Small-pox in Man: Dr. S. Monckton Copeman.—The Colour-Physiology of Higher Crustacea: F. Keeble and Dr. F W. Gamble.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—On Electrons: Sir Oliver Lodge, F.R.S.

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